THE IMPORTANCE OF SEEDS

What Seeds Are and Do: An Introduction

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SEEDS are many things.

Above all else, they are a way of survival of their species. They are a way by which embryonic life can be almost suspended and then revived to new development, even years after the parents are dead and gone.

Seeds protect and sustain life. They are highly organized fortresses, well stocked with special supplies of food against long siege.

Seeds are vehicles for the spread of new life from place to place by the elements and by animals and people.

Seeds are food for man and animals and other living things.

Seeds are raw material for the fashioning of myriad products by people.

Seeds are wealth. They are beauty. They are a symbol—a symbol of beginnings. They are carriers of aid, of friendship, of good will.

Seeds are a source of wonder. They are objects of earnest inquiry in man's ceaseless search for understanding of living things.

Seeds of unwanted kinds are as enemies; they are a source of trouble.

Seeds are many things, but everything about seeds—their numbers and forms and structures—has a bearing on their main purpose, to insure continuing life. Seeds are containers of embryonic plants, the embryos of a new generation.

SEEDS are borne by two great and different classes of plants.

One group, less highly developed than the other, produce "naked" seeds that develop from "naked" ovules.

In plants of the more highly developed and much larger class, the ovule and the seed develop within an ovary, the seed vessel. The ovary is the part of the flower that contains the ovule with its egg, or female sex cell. The ovary later becomes a fruit with the developed ovule or ovules—seeds—inside. This group of plants we call angiosperms, a word that means vessels for seeds.

Plants of the other group, the gymnosperms, the "naked seed" plants, have no ovaries, no flowers, and no fruits, although they do have seeds. Gymnosperms include the cone-bearing trees, the conifers. Their seeds are borne in pairs at the bases of the scales of the cones.

Deep within the ovary of the mother flower (or between the scales of a seed cone) lies the ovule, which contains an embryo sac and its tiny egg. The egg must be fertilized by a sperm cell from a pollen tube before it can start to develop into an embryo and so perpetuate the parent's life.

Along with the embryo there develops a special store of food, the embryo's own special "formula" or diet for its use after it is separated from its mother plant.

Every seed contains carbohydrates, proteins, fats, and minerals to nourish the embryonic plant within. The nature and proportions of each of them differ among the many kinds of seeds. Some seeds, like corn, are predominantly starchy. Seeds of flax and sunflower are oily or fat. Others, such as peas and beans, are notable for their high content of protein.

Some seeds (such as the seeds of orchids, which are like specks of dust) contain only tiny bits of stored food because they are so small. Large seeds may contain a billion times more food than the smallest ones.

Some kinds of seed have most of their reserve supplies packed inside their seed leaves. Others have it packed in tissues developed from the embryo sac, called endosperm, or from the cells of the ovule that surrounded the embryo sac.

The seed usually is well protected through its development. This protection differs greatly among different kinds in degree and in the way it is provided.

The ovary and the tissues that are attached to it become the fruit of the plant. The seeds (formed by ovules in the ovary) of plants having large or fleshy fruits are deeply protected therefore so that we never see them before maturity unless we open the fruit to find them.

Although the seeds of gymnosperms are said to be naked, they nearly always have some protection during development. The seeds of the pine tree and other conifers, for example, are hidden at the bases of the scales of the cone. The cone scales of some pines separate to release the seeds as soon as they are mature. Others remain closed for years.

The fruit tissues that enclose some seeds are scanty and are attached to the coat of the seed. A kernel of corn, for example, is more than a seed—it is a one-seeded fruit. The kernel is nearly all seed, but a thin layer of ovary tissue surrounds the seed and has grown together with the seedcoat in such a way that we can hardly see the tissue.

Many structures that we call seeds are actually fruits. Most of them, such as the fruits of the cereals and other grasses, lettuce, and spinach, contain only one seed. Members of the carrot family produce two-parted fruits, each with one seed. Some fruits, such as those of beets, have one or several seeds.

Botanists identify the various types of fruits and give them specific names, but our purpose here is served if we deal with the small, dry, one- or few-seeded fruits, which we are accustomed to plant like seeds, as though they were seeds.

Seeds of some species develop in the mother plant with amazing speed. Some others are surprisingly slow. A chickweed plant that is pulled from the garden and thrown aside at the time its flowers first open may form some seeds before it withers and dies.

Most familiar plants form their seeds during a period of several days to a few weeks following pollination. Pine trees, however, take 2 to 3 years to mature their seeds. The fruit of the sea palm is said to need 7 to 10 years to mature.

ANOTHER ASPECT of the survival of plants is that the seed-bearing species can be perpetuated in two ways.

One, which we have been discussing, is sexual—that is, by means of seeds, which develop from fertilized egg cells.

The other is asexual, or vegetative, as we usually say, by means of such parts as buds, pieces of root, and pieces of stem with attached buds, bulbs, and tubers.

The seeds of some plants—like potatoes, cultivated tree fruits, grapes, berries, and many ornamental garden plants—do not come true to variety. Their seeds therefore are worthless for perpetuating the varieties we plant in gardens and orchards.

For them, we must use vegetative propagation. We can grow apple trees, grapevines, potatoes, or strawberry plants from seeds, but the plants and their fruits (or tubers) will be unlike those of the varieties that produced the seeds.

That is because most seeds, as we have seen, develop after the union of male and female reproductive cells. The seeds perpetuate the hereditary characteristics contributed by both the male and female cells. Seeds of plants like potatoes, apples, pears, and tulips fail to come true to variety because their sex cells carry random assortments of mixed-up sets of characters. Among the offspring of the numberless chance unions that occur in such plants, hardly any two are alike. The plants from seeds of most species come reasonably true to variety if precautions are taken to keep the pollen of undesired types from reaching the flowers of desired types.

We must note a rare exception. A few kinds of plants, such as some species of grasses and of *Citrus*, produce asexual seeds, whose embryos develop entirely from cells of the ovule outside the egg apparatus. No fertilization of an egg cell is involved. There is no mixture of characters from pollen cells with those of the mother cells. The embryo is formed entirely from mother-plant cells and therefore is identical with the mother plant in its hereditary makeup. Such asexual seeds, therefore, come true to variety and afford the unusual opportunity of accomplishing "vegetative" propagation by means of seeds. Except for such rare instances, however, seed propagation means sexual propagation, and asexual or vegetative propagation means propagation by some means other than seeds.

Plants that do come true to variety from seed of sexual origin can also be propagated asexually from stem cuttings or other appropriate parts of the plant under favorable conditions.

Why, then, do we consider the seeds of such plants of great importance? Why are seeds essential if we can perpetuate the plants without seeds?

The answer is that conditions rarely are favorable or practicable for their vegetative propagation.

A prohibitive amount of work would be required for the vegetative propagation of the billions upon billions of such plants that we need to grow every year. An even greater obstacle is that there is no feasible way to keep these "vegetative" plants alive through periods of great cold, drought, or flood. If such plants are killed before they produce seed, that is the end of their line.

The kinds and varieties of plants that fail to produce viable seeds—that is, seeds that can grow or develop—must be perpetuated by asexual means. There is no other way. Such diverse plants as certain grasses, bananas, and garlic produce no seeds, but each has an asexual feature (a vegetative structure) by which it can be multiplied.

Sometimes, for a particular reason, growers resort to vegetative propagation of a kind of plant that is normally grown only from seeds.

Small farmers in the hills of Vietnam grow cabbage year after year without the use of seeds. The climate there is not cool enough at any time to induce flowering and seed production in cabbage, and the farmers cannot import seeds for each planting. The farmers therefore make cuttings from the stumps of the cabbage plants after the heads are harvested. They plant the pieces of stump, each of which has one or more side buds. Roots soon develop. The buds grow and produce new cabbage plants that will develop heads. The process is repeated for each crop.

This method of growing cabbage would be impossible where the seasons become too cold, too hot, too wet, or too dry for the continued survival of the vegetative stage of the plant.

The enormous numbers of seeds that single plants of some species produce make it feasible to increase seed supplies at almost fantastically rapid rates. Single plants of other species produce few seeds, and the rates of increase are ploddingly slow.

One tobacco plant may produce as many as 1 million seeds. The average is about 200 thousand seeds. The garden pea plant produces a few dozen seeds at best.

The possible rate of spread of some plants over an area by seeds therefore is astronomical. With other plants, the rate is modest or slow.

Even the relatively slow rates of seed increase among annual and biennial plants are fast and easy, compared to most vegetative propagation.

Species and varieties of hardy perennial plants that spread by runners (creeping stems above the soil surface), stolons (creeping stems below the soil surface), bulbs (arrangements of fleshy leaf bases on a drastically shortened stem), and tubers (greatly thickened underground stems), are especially adapted to survival for long periods without depending on seeds, although they may also produce seeds. Seeds of these kinds of plants often do not come true to variety.

Plants are able to spread naturally only very slowly if seeds are absent. They can only creep. Their vegetative structures do not fly on the wind, float on the water, or ride on animals to distant sites as easily as seeds do. Vegetative reproductive parts may be torn from parent plants by animals or by storms and later may take root after being carried some distance. Vegetative spread nevertheless is slow and cumbersome in nature, compared to spreading by seeds.

Seeds are the protectors as well as the propagators of their kinds. Thousands of kinds of plants have evolved in such ways that they cannot survive, even in the regions where they are best adapted, if they produce no seeds.

Seeds of most plants are the very means of survival of the species. They carry the parent germ plasm, variously protected against heat, cold, drought, and water from one growing season that is suitable for growth of the species to the next.

Most kinds of seeds will live considerably longer than the time from one growing season to the next if their surroundings are not too extreme for their respective characteristics. Some seeds normally keep alive under natural conditions above ground only a year or two. Others can keep alive for a score of years or more. A few, such as the seeds of silver maple, remain viable only a few days if they are not kept moist and cool.

Some kinds can survive deep burial in the soil, dry or moist, for 10 to 20 years or longer. In one famous experiment, started in 1902, J. W. T. Duvel, of the Department of Agriculture, placed some seeds in soil in flowerpots, so he could find them later. He then buried the pots and all. At intervals he dug up the pots, recovered the seeds, and then planted them under favorable conditions for germination. More than 50 of 107 species tested were viable after 20 years. Many weed seeds remain viable for a very long time if they are buried deeply.

Seeds of common evening-primrose and mullein have been known to remain viable after 70 years in soil.

Most crop seeds keep best for one or a few years when they are stored in a dry place. Exposure to warm, moist air shortens their life. Repeated wetting or submergence in water soon kills most of them. Seeds of plants that grow in water, on the other hand, are not soon harmed by water.

Onion seeds kept in a warm, humid place will lose their life in a few months. When they are well dried and sealed in glass, they remain viable more than a dozen years at room temperature. If seeds are relatively dry, most kinds will tolerate for years extreme cold that would quickly kill their parent plants.

Most seeds also tolerate prolonged hot weather if they are dry. Seeds of muskmelon have produced good plants in the field after storage in a hot, dry office for 30 years. Seeds of Indian-mallow, a common weed, have germinated after 70 years of dry storage. Seeds of *Mimosa*, *Cassia*, and some other genera have germinated after being kept in a herbarium more than 200 years.

The seeds of *Lagenaria*, a gourd, are not harmed by the immersion of the fruits in sea water for a year, long enough for the fruits to float across an ocean. Water may enter the fruits and wet the seeds. Lotus seeds estimated to be 800 to 1,200 years old have germinated.

The stories, however, about the finding of viable seeds 2 thousand to 3 thousand years old in Egyptian tombs are not true. Viable barley seeds found in the wrappings of a mummy were traced to the new straw in which the mummy was packed for shipment to a museum. Viable seeds of corn, squash, and beans found in caves and ancient ruins of cliff dwellings had not lain there for hundreds of years—pack rats or other creatures had carried them in not long before the archeologists found them.

The long "storage" life of the embryo within the seed not only helps insure survival of the species, it makes possible the distribution or spread of the species over long distances, either in the wild or by the agency of man.

VIABLE SEEDS probably are never completely inactive. Vital processes go on as a seed awaits conditions favorable for germination and plant growth. If we knew how to arrest or suspend all these processes completely, it would be possible theoretically to retain viability indefinitely. We do not know how to do that.

Activity within the seed may be so low that we cannot measure it by any known method. In time, however, if the seed does not encounter conditions that will permit it to grow, unidentified substances become exhausted or they deteriorate, and germinating power is lost. The seed dies. Warmth and moisture hasten the exhausting life processes and shorten the life of the seed. Dryness and cold slow down activities, conserve vital substances, and protect the delicately balanced systems within the seed.

SEEDS POSSESS remarkably complex and effective protective mechanisms that help insure survival.

Consider a tender plant that grows in a region of sharply different seasons and matures its seeds and drops them to the ground while the weather is still favorable for growth. If those seeds grow promptly, the new plant surely will be killed when winter comes.

In such situations, seeds that grow promptly are wasted because they fail to perpetuate the parents.

Many seeds therefore have a rhythm of ability to grow that coincides with the rhythm of the seasons. They have a delayed-action mechanism, a natural timeclock, which insures that the seeds will remain dormant until another growing season rolls around—a season long enough to permit another generation of seeds to mature.

Many kinds of seeds remain dormant—fail to grow upon planting—for a while after separation from the mother plant. The length of the dormancy and the nature of the delaying mechanism differ greatly among species and varieties.

Dormancy that is due to water-resistant ("hard") seedcoats may last for years, until enough water has soaked into the seed for it to germinate. Tiny nicks or scratches in the seedcoat will permit water to enter, thus breaking the dormancy. Natural abrasion of the seeds—by the freezing and thawing of soil or by their movement among rock particles by water—permits water to enter the seed. Hard seeds of crop plants are abraded artificially to induce germination. Dormancies due to some other mechanisms may be overcome less easily.

Some dormant seeds, before they will grow, must go through a long period of cool temperature while they are moist. They must go through conditions that simulate a cold, moist soil during autumn or winter. The rhythm of the seasons must be simulated in the environment of the seeds if they are to grow.

Some seeds lie dormant, although they are in moist soil, until they are exposed to light. Certain weed seeds never germinate deep below the soil surface, but grow quickly after they are brought to the surface when the soil is worked.

Still other seeds fail to grow soon after separation from the mother plant because they are immature. Structural developments or chemical processes, or both, must be completed before they can grow. The naked seed of the ginkgo tree drops to the ground in the autumn long before its embryo is fully grown. The embryo must continue its development for many months, nourished by the foods stored around it, before it is mature enough to break out of the seedcoat and grow.

Some seeds in a nondormant state after harvest can be pushed into a dormant state. Upon exposure to unfavorably warm and moist conditions, some varieties of lettuce seed become dormant, although they are capable of germinating under favorable conditions. It is as though their growth processes recoiled, or went into reverse, in the face of a situation that would be unfavorable for the plants developed from those seeds.

Witchweed, a semiparasitic seed-bearing plant, has an unusual survival device. Witchweed is a parasite on many species of crop plants and weeds. Its almost microscopic seeds may lie dormant in the soil for many years if no suitable stimulator plant grows close to them. When the root of a stimulator plant grows close to them, some substance from the root causes the seeds to germinate. The young witchweed plants promptly become parasitic on the roots of any host that caused the seeds to germinate. If a nonhost should cause the seeds to germinate in the absence of a host, the witchweed seedlings die.

MANY species of plants are widespread because their seeds are great travelers. Besides the special features that insure perpetuation of their respective species, plants have other features for spreading the species as far and wide as they are able to grow.

Most of the familiar structures that aid in the natural transport of seeds involve fruits rather than the seeds alone. (As I said, a large proportion of the plant parts we call seeds are actually tiny, dry fruits containing one or a few seeds.)

The windblown dandelion and thistle "seeds" are one-seeded fruits, called achenes. To each is attached a feathery pappus that serves as a sail and a parachute.

The "sticktights" of Spanish-needle are barbed achenes that catch in the coats of animals and people to be carried afar.

A "tickseed" of the beggarweed plant is a one-seeded fragment of its leguminous pod (fruit). It is covered with minute hooks that make it "sticky."

The flying "seed" of the maple tree

is a samara, a one-seeded, one-winged fruit.

The water-resistant seeds in buoyant fruits, large or small, one-seeded or many-seeded, may be carried great distances by water. Coconuts, gourds, and the tiny berries of asparagus are examples.

A few kinds of plants distribute their seeds widely as the entire aboveground part of the mature plant tumbles about over the land, blown by the wind. The Russian-thistle is noteworthy among these tumbleweeds. They sometimes roll for many miles, even over fences and other obstructions, scattering seeds as they go.

Some seeds travel on their own. They need not depend on features of their enclosing fruits or of their mother plants as aids to transportation. The coats of some seeds resemble certain surface features of fruits.

The coat of the pine seed is expanded into a wing, which carries it a short distance.

The seed of the milkweed has a tuft of long, silky hairs attached to its coat. The wind carries this seed far.

When a seed of flax becomes wet, as by rain, its surface becomes gelatinous. It adheres to whatever touches it and is carried away.

The coats of many seeds are resistant to moisture and to the digestive fluids of animals. If such seeds happen to escape grinding by stones in the crops of birds or by the teeth of animals that eat them, the seeds will pass unharmed through the alimentary tract. Some of them reach congenial soil many miles from where the animal got them.

The seeds of the mesquite tree have been distributed by cattle over millions of acres of formerly good grazing lands in the Southwest.

Seedlings of cherry, dogwood, and holly commonly appear where seeds have been dropped by birds far from any parent tree.

UNWANTED PLANTS make seeds, too. It seems that undesirable or unwanted plants generally are more prolific seed producers than most of the crop plants that we strive to grow. One investigator estimated that one large tumbling pigweed produces more than 10 million seeds. Many kinds produce 100 thousand to 200 thousand seeds per plant.

Weeds are the pests they are partly because they produce so many seeds. More than that, though: The seed and the plants that grow from them have a remarkable capacity for survival. Reproductiveness and survival value have evolved to a high level by natural selection. Seeds of many weeds are such potent survivors and successful travelers that their species have become nuisances over much of the world.

Farmers and gardeners must contend with weeds that arise from seeds. They appear to come suddenly from nowhere—or everywhere. They arrive unnoticed by air, by water, by animals, and by man's devices.

Earlier arrivals have accumulated in the soil and lie there waiting for the husbandman to stir them up to the surface, where they seemingly explode into growth. One investigator recovered 10 thousand to 30 thousand viable weed seeds in patches of soil about a yard square and 10 inches deep. Various kinds of seeds kept dormant a long time by their respective mechanisms persistently produce successive waves of noisome seedlings each time the soil is cultivated.

Weeds thus continue to appear although the grower has not allowed a parent plant to produce seed on the site for years. Survival value! Many weed seeds will survive in the soil 20 years and some for longer than 70 years.

Many weed seeds have nearly the same size, shape, and density as the crop seeds with which they may become mixed. The complete removal of such weed seeds from crop seeds is difficult and expensive. Weed seeds that contaminate seeds for food or industrial use lower the grade and value of the latter. Weed seeds will continue to pose problems for gardeners, farmers, and processors.

SEEDS are an aid in efforts to improve plants.

It is said sometimes—incorrectly—that plant improvement can occur only through seeds. Many improved varieties of plants have originated as mutations in vegetative (asexual) cells and have been perpetuated vegetatively (asexually). No seeds are involved in such instances, although the plants may be seed producers.

Most purposeful plant "improvements," however, have come about through sexual reproduction and the consequent formation of seeds. Useful variations in hereditary characteristics occur much oftener incidental to sexual propagation than in asexually propagated plants. Plant improvement would be extremely slow and uncertain, indeed, if we could only sit and wait for useful mutations to occur.

Man learned long ago that like begets like among annual and biennial plants. He learned that he could gradually upgrade the plants he grew year after year by saving and planting the seeds produced by the most desirable plants.

We speak of "seed selection" when we really should say "parent selection." Man nevertheless has made productive use of the capacity of seeds to contain, preserve, and perpetuate the properties of selected parent plants. For thousands of years he has been gradually improving plants by the parental characters he has helped to perpetuate.

As research has revealed more and more about how plant characters are inherited, seeds have become an increasingly valuable element in the purposeful modification of plants. Seeds are not only a means of perpetuating and multiplying plants but an essential feature of the most rapid and practicable way of progressively improving them.

As additional desirable plant characters (or more desirable degrees of existing traits) are found in a potential parent plant, they can be combined with other desirable characters in a second potential parent by mating the two. Through the seed that results from this planned union, the desired combination of characters is captured and retained. A step upward is taken.

Large progenies generally can be developed rather quickly and inexpensively through the agency of seeds. Large numbers greatly increase the probability of finding truly superior plants for further increase and selection or for further mating with other desirable parent plants.

The compactness and longevity of most seeds enable the plant breeder to store collections of germ plasm in small space at small cost and safely and also to distribute germ plasm readily to distant points. Seeds thus help man in his efforts to produce better plants so that he may live better.

SOMEWHAT DIFFERENT but related aspects of survival have to do with the utility and beauty of seeds—the reasons why we grow them, breed them, and husband their spark of life.

Seeds are the world's principal human food. The American Indians, for example, gathered the seeds of about 250 species in more than 30 families of plants for food. Among these were seeds of more than 50 kinds of pine, nut trees, and oak; more than 40 kinds of grasses, of which corn is most important; 30-odd members of the thistle family (like sagebrush and sunflower), and 20 of the goosefoot family (like saltbush and lambsquarters).

Seeds of the wild species used by the Indians are no less wholesome and nutritious today than in the distant past. Most of those species, however, are less productive or are more trouble to grow or harvest than our present crop plants. Or, the seeds are more trouble to prepare or less attractive to our tastes than the ones we now depend on.

All dry edible seeds are highly concentrated foods.

For human food, the seeds of certain grasses, the cereals, are by far the most important group. The seeds of wheat provide more human food than any other plant or animal product, and the seeds of rice are second in importance the world over.

The seeds of rye, barley, corn, sorghums, millets, and oats are also important for human food in different regions of the world. Rye and corn are most important in the Americas and Europe. Rice, wheat, and sorghums are dominant in the Far East.

About one-fourth of the supply of human energy in the United States comes from seeds of the cereals; in Europe, about one-half; and in the Far East, about three-fourths. These seeds are relatively easy to grow, harvest, and store. One or another of them can be grown wherever there is any agriculture at all.

SEEDS are the raw materials for making a great diversity of important products for use in industry and the arts and for making pharmaceuticals, cosmetics, and alcoholic beverages.

Among these various purposes, the oilseeds have the widest range of uses.

Millions of tons of both oily and starchy seeds are used every year in this country for products other than food and feed.

MOST SEEDS are objects of beauty of form, proportion, surface, and color.

Many seeds are so small that their beautiful features escape us. Many others, although large enough to see easily, are such common, everyday objects that we do not really see them. They are, however, worth our careful observation.

The first and most obvious beauty in most true seeds is in the perfection of their simple forms. Their outlines or silhouettes exhibit endless variations in the curve of beauty. In their entirety, too, we find wide ranges of proportion and different graceful and simple masses that are pleasing to look upon.

The sphere is a thing of beauty in itself, although quite unadorned. Artists have tried to produce nonspherical "abstract" forms that possess such grace and proportion as to call forth a satisfying emotional or intellectual response in the beholder. Some of the nicest of such forms lie all about us, unnoticed, in seeds. The commonest are such basic forms as the sphere, the teardrop, and the ovoid and other variations of the spheroid.

Some of these curving shapes are flattened, elongated, or tapered in pleasing ways. Sometimes they are truncated or sculptured into somewhat rough and irregular form. They may bear prominent appendages, such as wings, hooks, bristles, or silky hairs. Most seeds show a smooth flow of line and surface that is perfection itself.

The details of the surface relief of many seeds are even more beautiful in design and precision than the mass of the seed as a whole. Often you can find minute surface characters of surprising kinds. Surfaces that appear plain and smooth to the unaided eye may be revealed under a good hand lens to have beautiful textures.

Surfaces may be grained or pebbled. They may have ridges like those of Doric columns. They may bear geometric patterns in tiny relief, forming hexagons, as in a comb of honey, or minute dimples may cover the surface. Some irregular surface patterns of surprising beauty sometimes appear under the lens. Surfaces may be a dull matte, or highly glossy, or anywhere in between.

Last but not least in the beauty of seeds are their surface colors. They may be snow white or jet black. The color may be a single solid one, or two or more may be scattered about at random. Colors may form definite patterns that are distinctive and characteristic of the species and variety. The colors may be almost any hue of the rainbow—reds, pinks, yellows, greens, purples—and shades of ivory, tan, brown, steely blue, and purplish black.

Look for all you can see with the unaided eye. Then look at smaller seeds and the surfaces of large seeds with a good hand lens. You will be delighted with what you find.

There is still another beauty, a potential beauty in seeds, that can be seen only as the seed fulfills its ultimate purpose—the production of a new plant possessing its own beauty. This is perhaps the greatest of all: Beauty of general form; grace of stem; the shape, sheen, and color of the leaf; and finally the loveliness of the flower or the lusciousness of a fruit. The cycle is complete, and so we are back to the beauty of a seed.

SEEDS are a symbol. They color our language and habits of thought.

From prehistoric times man has understood the role of seeds. Ancient languages, ancient cultures, and our own contain many words and concepts based on this understanding. The Bible contains several such examples, including the parable of the sower, the use of the word "seed" to mean offspring or progeny, and references to good and bad seed.

Our language contains both common and technical terms involving "seed," although the meanings are quite unrelated to the subject of plants.

The meanings recognize, however, some metaphoric connection in one way or another. "Seed" is a noun, an adjective, and a verb.

Watermen speak of seed oysters, seed pearls, and seed fish. The optician speaks of seeds in glass. The chemist seeds a solution with a crystal to induce crystallization. We speak of the seed of an idea or a plan.

WE KNOW a great deal about how seeds are formed and what they do, but we know only a little about why that is so. Many purely practical questions still cannot be answered. We wonder about many features of seeds and their behavior.

Scientists study seeds for two kinds of reasons. It is desirable to learn everything possible about seeds in order that man can produce and use them more efficiently and effectively. Seeds or parts of seeds are especially convenient forms of living material for the study of the fundamentals of life processes in plants.

RESEARCHERS are conducting more inquiries into seeds today than ever before, and still our wonder grows.

Why does a very dry seed become so well protected and so insensitive that it can tolerate sharp, deep-freeze temperatures for years, with no harm and no loss of vigor?

A light-sensitive seed, while dry, may be so well protected and so insensitive that it is quite unaffected by daylong exposure to sunlight, yet, after it becomes moist, it may respond to a light exposure from a flash lamp as short as one one-thousandth of a second. Exactly what chain of events is set in motion by that flash, and how?

Why do some seeds require alternating temperatures in order to grow, while others do not?

Why do some seeds live for decades and scores of years, while others, apparently as well protected, die in 2 or 3 years?

Why do some small plants produce seeds that are much larger than the seeds of some much larger plants?

Why does one kind of seed develop completely in a few days while another takes years?

How is it that seeds are so wondrously different among species, and yet all are quite evidently evolved to accomplish exactly the same thing?

Seeds are a source of wonder.

Seeds are many things.

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